American Journal of

Food Technology

ISSN 1557-4571

Academic
Journals Inc.

www.academicjournals.com

American Journal of Food Technology 2 (3): 153-160, 2007
ISSN 1557-4571
© 2007 Academic Journals

Determination of the Chemical Composition of Bush Meats Found in Nigeria

Francis Olawale Abulude
Department of General Studies, Federal College of Agriculture,
Akure 340001, Ondo State, Nigeria

Abstract: The study assessed the anatomical weight, proximate, mineral and *in vitro* digestibility compositions. The economic and organoleptic evaluations were conducted using standard methods. Protein and ash contents were high in all the samples, fat and fibre were low. Anatomical values showed that life weights of giant rat and grasscutter were the highest, 1161.2 and 3164 g, respectively. The abundant mineral values (mg 100 g^{-1}) were K, Na, Ca and Mg having mean values of 529.8, 622.6, 477.3 and 514.5, respectively. The trace elements were present in amounts that could contribute to the RDA. The lead levels were low, but it would be advisable not to consume meats that are high in this element due to its carcinogenic effect. The digestibility values were between 59.96 (pigeon bird) and 68.25% (giant rat). Biological Value (BV), Net Protein Utilization (NPU) and Net Protein Value (NPV) were high. Economically, the cheaper sources of protein were found to be bat, cattle egret and cuban boa. From the results, it was observed that nutritional qualities of the bush meats were comparable to conventional meats.

Key words: Bush meats, meat quality, anatomical composition, economic feasibility, RDA

INTRODUCTION

Bush meats are group of animals that exist in the forest reserve. The major species in Nigeria include primates, pholidota, rodents, carnivora, hyracoidea, artiodactyla, reptiles and avian among others. The task of hunting of these animals is either simple or difficult depending on the hunter. They are either killed with traps or with guns. Human activities, like farming and felling of trees are on the increase in Nigeria and these have been affecting the population of bush meat (Abulude, 2004a).

The inadequate supply of animal protein in developing countries has been attributed to inadequate production and high cost of conventional sources of animals proteins (Poultry, goat, meat, beef, mutton and pork) hence, an average Nigeria consumes only about a quarter of his minimum daily animal protein requirement (Oke *et al*., 2004). To meet this problem of shortage of conventional meats, alternatives have been sourced for. To this end there has been increase in the consumption of bush meat. This increase has bridge the supply and demand protein gap (Abulude, 2004b).

Many researchers have (Abdullahi, 2000; Adeyeye, 2002, 2003; Oke *et al*., 2004; Omojola *et al*., 2004; Abulude, 2004a) reported on meat of different species of edible farm animals, especially in Nigeria, but none have worked on these bush meats reported on in this paper. The aim of this study is to examine the nutrients, minerals, anatomical weights, *in vitro* digestibility, organoleptic values and economic feasibility of bush meats consumed in Nigeria. It is hope that this finding will add to nutrition data.

MATERIALS AND METHODS

The bush meat samples (Table 1) of ten different animals were colleted from the forest reserve of Federal College of Agriculture, Akure Campus, Nigeria, during the raining months of 2004. The rats

Table 1: Names of the meat samples used for the analysis

English name	Local name (Y)	Scientific name
Giant rat	Okete	*Cricetomys gambianus*
Tullberg's rat	Emon	*Praomys tullbergi*
Grass cutter	Oya/okuru	*Thryonomys swinderianus*
Albino rat	Emo funfun	*Wistar rat*
Tree squirrel	Okere	*Scicurus carolinensis*
Cuban boa	-	*Epicrates anquifer*
Python	Ere/ojola	*Python regius*
Cattle egret	Lekeleke	*Bubulus ibis*
Pigeon bird	Eyele	*Columba guinea* G
Bat	Adon	*Eidolon helron*

Y-Yoruba name

(giant rat, Tullberg's rat, grasscutter, albino rat, tree squirrel), snakes (Cuban boa and python) and birds samples (cattle egret, pigeon bird and bat) were scarified, defeather and deskined, weighed, dissected to separate the parts and weighed in the Chemistry laboratory of Federal College of Agriculture, Akure, Nigeria. The meats were oven dried at 105°C between 6-10 h depending on the samples, ground in Kenwood blender, sieved (45 mm) and stored prior to analyses. Samples were analyzed for proximate composition using AOAC (1990) procedure. Carbohydrate was determined by difference. Minerals were analyzed using the Pearson (1981) methods. Digestibility, Biological Value (BV), Net Protein Utilization (NPU) and NPV were determined using the methods of Adeola (1995). Oganoleptic evaluation was carried at by a panel of 10 judges to evaluate the attractiveness, tenderness, flavor, texture, juiciness and overall acceptability on a 9-point hedonic scale (Land and Shepard, 1988). Economic feasibility was calculated for 100 g protein (NACA, 1989):

$$\text{Rate of 100 g (protein) in Naira (\#)} = \frac{\text{Price of 1 kg of meat sample}}{\text{Amount of protein 1 kg of meat sample}} \times 100$$

All determinations were in triplicate. Statistical evaluations were made using SPSS for windows.

RESULTS AND DISCUSSION

The anatomical weight compositions of samples (wet weight in g) are shown in Table 2. The life weight ranged between 87.4 and 3164 in rats, 239-250 in snakes and 218-300 in birds. Most of the parts weighted in rats were consistently higher than those in snakes and birds. The life weight, intestine and length size under this study were higher than those recorded for crabs (Adeyeye, 2002). These were due to the differences in physiological compositions of the different species.

The chemical compositions of the edible portions of the bush meats selected according to their availability in the forest are shown in Table 3. Protein content of egret (76.72%), boa (63.50%), pigeon (60.63%) and bat (56.12%) were lower than those reported previously for mussel meats (78.0%; Vildiz *et al*., 2005) and cheliped muscle of crab (85-87%; Adeyeye, 2002), but higher then values recorded for fish (46.4%), beef (18%), lamb (16%) and pork (10%) (Abdullahi, 2000; Pearson, 1981; Guner *et al*., 1998). Proteins have many different biological functions: they are associated with enzymatic reactions, transport, regulation of metabolism, defence, structural elements storage. This means that a pattern can be expected, depending on different physiological activities of individuals throughout the year. Protein contents of the bush meats have been found to be of high quality similar or higher to that of meat and fish. The relative fat content varied from one meat to another but most of the species showed fat values between 2.14 and 13.28%. They belong to low fat class according to Ackman's (1989) classification, indicating the content of high ester values and good quality oils. The

Table 2: Anatomical weight of samples[a] analyzed (wet weight in g)

Parameters	1	2	3	4	5	6	7	8	9	10
Life weight	1161.2	87.4	3164	263.3	274.0	239	250	300	28.9	218
Head	108.8	10.8	394	26.6	30.6	1.0	10.1	19.3	10.5	10.0
Length (cm)	37.5	13.5	50.4	10.5	20.6	10.2	105.0	-	-	-
Trunk	-	-	-	-	-	4.0	6.5	-	-	-
Liver	39.1	10.5	43.5	8.5	10.8	16.3	17.0	5.0	6.4	6.0
Intestine	113.5	8.8	439.2	11.0	15.9	43.1	40.6	8.0	10.9	10.7
Heart	-	-	13.3	1.0	3.7	0.8	1.2	3.1	2.8	1.7
Right arm	53.4	3.3	221	12.5	4.3	-	-	23.2	20.0	20.0
Left leg	54.5	3.3	223	12.5	4.2	-	-	24.0	20.9	20.0
Right leg	120.0	8.0	33.4	22.7	10.4	-	-	25.2	13.8	13.1
Left leg	123.1	8.1	333.5	22.7	10.4	-	-	25.3	14.1	13.2
Gizzard	-	-	-	-	-	-	-	13.3	6.1	5.2
Beak (cm)	-	-	-	-	-	-		5.9	1.7	-
Tail	40.3	1.80	24.0	4.5	6.0	-	-	-	-	-
Sex	Male	Female	Male	Male	Female	-	-	Male	Male	-

[a]1- Giant rat, 2- Tullberg's rat, 3- Grass cutter, 4- Albino rat, 5- Squirrel, 6- Cuban boa, 7- Python, 8- Cattle egret, 9- Pigeon bird, 10- Bat

Table 3: Proximate composition of samples analyzed

Sample	Protein	Fat	Fibre	Ash	Moisture	Carbohydrate
Giant rat	48.64	6.94	1.04	16.76	3.26	2.44
Tullberg's rat	48.59	6.51	ND	24.63	8.53	11.56
Grass cutter	22.70	4.20	ND	0.90	52.30	19.90
Albino rat	28.00	4.00	1.00	6.42	25.70	34.88
Tree squirrel	28.72	7.21	1.25	10.64	10.10	35.08
Cuban boa	63.50	3.77	2.53	20.11	3.38	5.97
Python	47.99	3.62	1.84	19.20	5.22	22.13
Cattle egret	76.72	2.14	0.14	6.41	4.79	9.83
Pigeon bird	60.63	13.38	2.68	15.54	7.05	0.84
Bat	56.12	6.42	1.62	10.22	6.12	19.50
Mean	49.16	5.18	1.15	13.10	12.65	16.21
±SD	16.34	3.13	0.84	7.42	15.39	12.28
CV (%)	33.25	53.89	55.63	56.65	121.69	75.74
CC	0.99	0.84	0.49	0.94	0.97	0.94

CC- Correlation coefficient, ±SD- Standard deviation, CV (%) - Coefficient of variation in percent

low contents of these samples would not allow then to contribute significantly as a source of non-visible oil to any diet in which they may be present. Moisture (3.26-25.70%) and ash (0.90-24.83%) were within the ranges covered for termite (Abulude, 2004a), cricket (Abulude, 2004b) and mushrooms (Abulude *et al*., 2004c). The content of moisture in all the samples would not allow any microbiological spoilage. The ash content of any sample is a measure of likely mineral content of such a sample. The low fibre content obtained in this study will help in easy digestion of the protein present in the samples. Carbohydrate content of these samples was calculated as difference between 100 and the total percentage of moisture, protein, fat and ash. There was a clear pattern in the total carbohydrate concentrations of the meats. The value was lowest in pigeon bird (0.84%) and highest in giant rat (35.08%). Carbohydrate has two major biological functions: as a long term energy store and as structural elements with lipids (Robledo *et al*., 1995). The implication of low carbohydrate contents of the samples is that it would be a good source of low dietary carbohydrate to the diabetic patients. The variations in proximate compositions of all the species in this study could be due to the location of catch, size, sex and types of food consumed.

Statistical results showed that correlation coefficients between the samples were highly positive in protein (0.99), ash (0.94), fat (0.84), moisture (0.49) and carbohydrate (0.94), but fibre was (-0.49). The implication of these values showed that they were highly related, but fibre did not agree with this. The mineral compositions varied with the type of meats (Table 4). The mean mineral contents (mg 100 g^{-1} DM) of the samples were: 6.4, 2.4, 529.8, 622.6, 477.3, 514.5, 2.5, 3.6 and 3.8 for Fe, Zn,

Table 4: Mineral composition of samples analyzed

Samples	Fe	Zn	K	Na	Ca	Mg	Cu	Mn	Cr
Giant rat	9.8	1.4	610	490	532	620	1.2	2.8	2.7
Tullberg's rat	7.6	1.2	260	275	482	578	1.0	2.5	3.5
Grass cutter	11.09	4.35	730	624	549	607	1.5	4.0	6.2
Albino rat	7.2	1.8	625	600	486	574	1.2	2.6	3.8
Tree squirrel	6.8	2.4	625	655	475	560	1.3	2.4	4.3
Cuban boa	3.8	3.5	38	714	248	489	5.5	2.5	2.5
Python	4.2	4.2	428	699	419	480	4.2	4.6	2.0
Cattle egret	5.1	3.3	555	518	407	481	4.3	4.3	4.3
Pigeon bird	5.0	1.0	194	611	507	538	2.9	5.7	3.7
Bat	5.2	1.2	473	640	489	488	1.5	4.8	4.6
Mean	6.64	2.44	529.8	622.6	477.3	514.5	2.5	3.6	3.8
±SD	2.31	1.30	180.4	72.6	47.2	554.0	1.7	1.2	1.2
CV (%)	35.36	55.41	36.3	11.7	9.9	10.0	66.9	33.2	32.0
Level of significance	NS	S	NS	NS	NS	NS	S	NS	NS

Level of significance at $p = 0.05$, NS-Not significance, S-Significant, ±SD- Standard Deviation, CV (%)-Coefficient of variation in percent

K, Na, Ca, Mg, Cu, Mnand Cr, respectively. The K, Na, Ca and Mg contents were significantly higher in the samples compared to micro elemental contents. In this study, the obtained Zn, Fe and Cu contents of the samples were relatively higher than 0.88, 1.56 and 0.49 mg 100 g^{-1}, respectively, reported by Guner *et al.* (1997) for fishes in Turkey.

The amount of Zn obtained in this report suggest that the samples could provide a significant portion of the Nigerian Food administration for Zn. Meat is the richest source of Zn in the diet and supplies one t hird to one half of the total Zn intake of meat eaters. Consistent findings to this study with respect to Fe in wild fruits were found by Anhwange *et al.* (2005), but similar Fe (5.20 mg 100 g^{-1}) and Zn (4.30 mg 100 g^{-1}) in millipedes contents obtained by Abulude and Folorunso (2003), when compared with the current results, Abulude (2004b) reported higher Cu (10.20 mg 100 g^{-1}) and lower Ca, Na and Mg contents. No significant differences in Pb and Cr were found in comparison with the data of Adeyeye (2000) and Hossan and Khan (2005) for prawns and shrimps, respectively.

The edible meats appeared to be good sources of K, Ma, Ca, Na and Fe. The differences in mineral contents of samples may be due to the soil, water, plant contents of their vicinities and the rate of uptake of minerals by each animal species. As current RDA of K, Ca, Na, Zn and Fe are 3750, 1200, 500, 15 and 10 (Wardlaw, 1999) a 100 g serving of the 'bush meats' would provide between 11.4-19.5, 33.9-45.8, 98-143, 6.7-28.91 and 38-119% of the adult daily requirement for the minerals.

Fe in meat is well absorbed, about 15-30%. It also enhances the absorption of iron from other sources lack of adequate iron in the diet is associated with poorer learning and decrease cognitive development (FAO/ WHO, 1997). In-general, protein rich diets are rich in Zn and this is provided by animal foods (Lean meat especially beef, red meats and shellfish). Since, these 'bush meats' are rich in protein, then the availability of Zn to consumers is guaranteed. According to Wardlaw (1999) foods with highest nutrient density for Cu are animals sources, the results obtained in this study corroborate this observation. Dietary Cu is not toxic to humans because intakes are usually low and because our bodies can regulate copper storage through biliary excretion. A large amount of evidence supports the view that Cr is an essential nutrient. For instance, humans on long-term total parental nutrition containing a low amount of Cr development impaired glucose tolerance, or hyperglycemia, with glucose spilling into the urine, a resistance to insulin action. These abnormalities can be reversed by Cr supplementation (Wardlaw, 1999).

Statistical results showed significant differences in Zn and Cu contents. There were high variations in the values.

The samples were evaluated for attractiveness, tenderness, flavor, texture, juiciness and overall acceptability (Table 5). The mean score for appearance ranged from 6.50 to 7.65. Grasscutter had the

Table 5: Organoleptic evaluation of meat samples analyzed

Samples	Attractiveness[a]	Tenderness[a]	Flavor[a]	Texture[a]	Juiciness[a]
Giant rat	6.50	7.50	7.20	7.20	7.10
Tullberg's rat	6.50	7.40	7.20	7.25	7.25
Grass cutter	7.65	7.92	7.10	7.10	7.00
Albino rat	6.50	6.99	7.10	7.10	7.00
Tree squirrel	6.95	7.72	7.20	7.25	7.00
Cuban boa	6.56	7.50	7.00	6.98	7.10
Python	6.50	7.10	7.00	6.99	7.00
Cattle egret	6.57	7.40	7.00	7.10	7.00
Pigeon bird	6.99	7.10	7.10	7.20	7.10
Bat	6.72	7.00	6.97	6.97	7.10

[a]- No significance difference ($p>0.05$)

highest score. Mean score for tenderness ranged from 6.99 to 7.92. Albino rat had the lowest score. Flavor scores ranged from 6.97 to 7.20, with the highest from giant rat, tullberg's rat and tree squirrel and the lowest from bat. Texture scores ranged from 6.97 to 7.15. The highest rated juiciness was recorded for grasscutter.

Color is an important indicator of the quality of fresh or cooked meat as such, the appearance of the meat (Van Oeckel *et al.*, 1999). The panel scores for the appearance showed that the colour of meat samples were not significantly ($p<0.05$) affected. The scores observed in this report were in agreement with results obtained for rabbit (Omojola *et al.*, 2004). Color of meat tends to become darker with ageand this may be of some importance with male meat which was darker than the female. Cooking is necessary to develop flavor. Mastication breaks down the fibre matrix and releases flavor-juices and the volatile aroma components into the month. The panelists assessment showed no significant ($p>0.05$) differences. Juiciness of meat is directly related to the intramuscular lipids and moisture content of meat (Gross *et al.*, 1986). In combination with water, the melted lipids constitute a broth which when retained in the meat, is release upon chewing. The results of juiciness showed that panelists enjoyed the juice produced by the panelists. Tenderness is regarded as the most important sensory attribute affecting meat acceptability (Warkup *et al.*, 1995). Meat tenderization is a multifunctional process dependent on a number of biological factors e.g., environment, sex, species and age.

The protein digestibilities of the samples examined are shown in Table 6. The values ranged from 59.96% (pigeon bird) to 68.25% (giant rat). The difference could be due to the varieties and location of catch. These values followed the trends on African Yam Bean (AYB) (Oshodi *et al.*, 1995; Adeyeye, 1997) and tropical plant seeds (Abulude, 2005), but not in agreement with values reported for maize-tilapia flour-blendes (Fasaasi *et al.*, 2005) and broiler meat (Oke *et al.*, 2004). The BV ranged from a low of 47.96 in pigeon bird to a high of 54.60% in giant rat, NPU varied between 28.92 to 37.27% and NPV 6.86 to 26.12%, respectively. All these values were in close agreement with those obtained for cowpea Abulude (2004c) and Adeola (1995). The BVs were lower than egg and milk proteins (RaO *et al.*, 1978). It has been improved in cowpea by fortification of the meal with sulphur amino-acids (Elegbede, 1998). The measure of BV and NPU of the protein is comparable with that obtained for a standard protein. BV value measures the proportion of absorbed protein from a diet that is retained while NPU measures the proportion of the consumed protein that is retained. By this standard, the most perfect protein source is egg, which is assigned the BV score of 100. Once egg white has been absorbed by the body, all of the protein it contains can be used to make new proteins with out any waste, but the score of the egg white drops slightly, to 94 in NPU. The average NPU scores for plant-derived proteins are lower than (55) those for animal-derived proteins (75) (Nieman *et al.*, 1992). Cooking methods, accompanying nutrients and complementary protein sources can all improve the NPU of a meal. It is known that supplementation of legumes with cysteine and methioninne dramatically improved BV and NPU of cowpea (Elegbede, 1998). It is therefore suggested that supplementation of these meat samples with sources of methionine and cysteine or other amino acids would improve both their BV and NPU and enhance their overall nutritive values.

Table 6: Digestibility of meat samples analyzed

Samples	Digestibility (%)	BV	NPU	NPV
Giant rat	68.25	54.60	37.27	17.43
Tullberg's rat	60.50	48.40	29.28	14.23
Grass cutter	61.45	49.16	30.21	6.86
Albino rat	61.25	49.00	29.85	8.36
Tree squirrel	64.10	51.26	32.86	1.72
Cuban boa	66.44	53.15	35.31	22.42
Python	64.85	51.86	33.63	16.14
Cattle egret	65.24	52.19	34.05	26.12
Pigeon bird	59.96	47.96	29.96	18.17
Bat	60.12	48.10	28.92	16.23
Mean	63.22	50.57	32.18	15.87
±SD	9.94	2.35	2.89	5.83
CV (%)	4.65	4.65	8.99	36.75

BV- Biological value, NPU- Net protein utilization, NPV- Net protein value, ±SD- Standard deviation, CV (%)- Coefficient of variation in percent

Table 7: Economic Feasibility of meat samples analyzed

Samples	Price of 1 kg of sample	Protein content/kg (g)	Price of 1000 g protein (#)
Giant rat	400	486.4	822.4
Tullberg's rat	250	485.9	514.5
Grass cutter	800	227	3524.2
Albino rat	150	280	535.7
Tree squirrel	200	387.2	516.7
Cuban boa	125	635	196.9
Python	150	479.9	312.6
Cattle egret	100	767.2	130.3
Pigeon bird	150	606.3	247.4
Bat	65	561.2	115.8

- Naira (Nigerian currency)

The significantly highest price of 100 g protein (#, Naira) as found in grass cutter (3524.2) and the significantly lowest was in bat (115.8) belonging to mammal and bird, respectively (Table 7). In the present study, meat samples of mammals had high price values. This may be due to the fact that they are not common in the foods sold at cafeterias and resturants.

Economically, cuban boa, cattle egret, pigeon bird and bat were found to be the cheapest sources of protein. In Nigeria, the conventional sources of meat proteins are mainly from livestock production, due to high cost of production, alternative meats were sourced for hence leading to back yard rearing of rats like rabbits, albino rats, grass cutters just to mention a few. These animals are reared because of their cheap feeding, high birth rate and palatability.

CONCLUSION

The present results showed that the bush meats samples have high protein values and valuable minerals. Their digestibilities were high. Economically, it was observed that the meat samples that produced the cheapest source of protein were cuban boa, cattle egret and bat, but if the rats are domesticated they would be excellent and cheaper sources of animal protein. Their nutritional qualities compared to the conventional meats-pork, beef, mutton and poultry. It is therefore advisable for people to take the advantages of their nutritional benefits.

ACKNOWLEDGMENT

The author is grateful to Messers Onuoha. Imoh Williams, Pius Adeluka; Ayorinde Oni, Gabriel Akinleye, I. Ajao and Miss Patricia Akinbuli. All of Federal College of Agriculture, Akure, Nigeria for the provision of cattle egret, tullberg's rat, grass cutter, cuban boa, giant rat, albino rat and pigeon bird, respectively and to Messers Oguntokun M.O and Oseke M.O for the determination of proximate and mineral compositions, respectively.

REFERENCES

Abdullahi, S.A., 2000. Evaluation of the nutrient composition of some freshwater fish family in Nigeria. J. Agric. Environ., 1: 141-150.

Abulude, F.O. and R.A. Folorunso, 2003. Preliminary studies on millipede: Proximate composition, nutritionally valuable minerals and phytate contents. Global J. Agric. Sci., 2: 68-71.

Abulude, F.O., E.I. Adeyeye and S.S. Asaolu, 2004. Metal levels in mushrooms consumed in South Western Nigeria. Adv. Food Sci., 26: 155-158.

Abulude, F.O., 2004a. Studies on termites (*Macroterms* sp.): Proximate composition, mineral contents and functional properties. Adv. Food Sci., 26: 150-154.

Abulude, F.O., 2004b. Proximate composition, mineral contents and functional properties of cricket (*Acheta* sp.). Pak. J. Sci. Ind. Res., 47: 212-213.

Abulude, F.O., 2004c. The influence of neem leaf extract on the *in vitro* net protein value of hulled and dehulled cowpea (*Vigna unguiculata* L. Walp.) flour, Nig. J. Tech. Educ. (In Press).

Abulude, F.O., 2005. *In vitro* digestibility of some tropical plant seeds. La Riv. Italiana Delle Sostanze Grasse. Vol. LXXXII, pp: 152-154.

Ackman, R.G., 1989. Nutritional composition of fats in sea foods. Prog. Food Nutr. Sci., 13: 161-241.

Adeola, O.F., 1995. Protein quality, chemical and mineral contents of some local grains. Final Diploma Thesis, Federal University of Technology, Akure, Nigeria, Unpublished.

Adeyeye, E.I., 1997. The effect of heat treatment on the *in vitro* multienzyme digestibility of protein of six varieties of African Yam Bean (*Sphenostylis stenocapa*) flour. Food Chem., 60: 509-512.

Adeyeye, E.I., 2000. Bio-concentration of macro and trace minerals in four prawns living in Lagos Lagoon. Pak. J. Sci. Ind. Res., 43: 367-373.

Adeyeye, E.I., 2002. Determination of the chemical composition of the nutritionally valuable parts of male and female common West African freshwater crabs *Sudananautes africanus*. Int. J. Food Sci. Nutr., 53: 189-196.

Anhwange, B.A., V.O. Ajibola and D.J. Oniye, 2005. Composition of bulk trace and some rare earth elements in the seeds of *Moringa oleifere* (Lam), *Deterium microcarpium* (Guill and Perr) and *Bauhinia monandra* (Kurz). J. Food Technol., 3: 290-293.

AOAC, 1990. Official Methods of Analysis. Association of Analytical Chemists, D.C. Washington, 18th Edn.

Elegbede, J.A., 1998. Legumes. In: Nutritional Quality of Plant Foods. Osagie, A.U. and O.U. Eka (Eds.), Academic Press Ltd., Lagos, pp: 53-83.

FAO/WHO, 1997. Protein quality evaluation. Report of a joint FAO/WHO export consultation held in M.D. Bethesda, USA.

Fasasi, O.S., I.A. Adeyemi and O.A. Fagbenro, 2005. Proximate composition and multi-enzyme *in vitro* protein digestibility of maize-tilapia flour blends. J. Food Technol., 3: 342-345.

Gross, H.R., P.R. Quland and S.C. Seldeman, 1986. Muscle as Food. Bechtel, P.P.J. (Ed.), Academic F.L. Press, pp: 45-52.

Guner, S., B. Dincer, N. Alemdag, A. Colak and M. Tufekci, 1998. Proximate composition and selected mineral content of commercially important fish species from the black sea. J. Food Agric., 78: 337-342.

Hossain, M.S. and Y.S.A. Khan, 2001. Trace metals in penaeid shrimp and spiny lobster from the Bay of Bengal. Sci. Asia, 27: 1-5.

Land, D.G. and R. Shepherd, 1988. Scaling and Ranking Methods. In: Sensory Analysis of Foods. Piggott, J.R. (Ed.). Elsevier Applied Sci. New York, pp: 155-185.

NACA, 1989. Integrated fish farming in China. NACA Technical Manual 7. A world food day publication of the network of agriculture centre in Asia and the pacific, Bangkok, Thailand, pp: 1-278.

Nieman, D.C., D.E. Butterworth and C.N. Nieman, 1992. Nutrition. 1st Edn., W.M.C. Brown Publishers, USA., pp: 164-166.

Oke, D.B., M.O. Oke, O.E. Fasina and O.T. Olugbesan, 2004. The evaluation of kolanut testa meal as a replacement for maize in broiler diets. 1: Performance characteristics. Proc. 9th Annual Conf. Animal Sci. Ass. Nigeria (ASAN). Sept 13th-16th 2004. Ebonyi State University, Abakaliki, Nigeria, pp: 28-30.

Omojola, A.B., O.A. Sokunbi, A.O.K. Adesehinwa and O.O. Ogunsola, 2004. Sensory score of rabbit meat as affected by delayed bleeding. Proc. 9th Annual Conf. Animal Sci. Ass. Nig. (ASAN). Sept 13th-16th. 2004. Ebonyi State University, Abakaliki, Nigeria, pp: 294-297.

Oshodi, A.A., K.O. Ipinmoroti, E.I. Adeyeye and G.M. Hall, 1995. *In vitro* multienzyme digestibility of protein of six varieties of African yam bean flours. J. Sci. Food Agric., 69: 373-377.

Pearson, 1981. The Chemical Analysis of Foods. Churchill, Livingstone, Edinburgh, UK., P5, pp: 30.

Rao, C.S., C.W. Deyoe and D.B. Parrish, 1978. Chemical and nutritional properties of organic and treated high moisture sorghum grain. J. Stored Prod. Res., 14: 95-102.

Rebledo, J.A.F., M.M. Santarem, P. Gonzales and A. Figueras, 1995. Seasonal variations in the biochemical compositiooon of the serum of *Mytilus galloprovincialis* Lmk. and its relationship to the reproductive cycle and parasitic load. Aquaculture, 133: 311-322.

Van Oeckel, M.S., N. Warmant and L.V. Bonkque, 1999. Measurement and production of pork color. Meat Sci., 52: 347-354.

Wardlaw, G.M., 1999. Perspectives in Nutrition. McGraw-Hill Companies. USA., pp: 506.

Warkup, C.C., S. Marie and G. Harrington, 1995. Expression of Tissue Proteinases and Regulation of Protein Degradation as Related to Meat Quality. Quality, A., D. Demeyer and F.J.M. Smulders (Ed.), Ecceamst. Utrecht. The Netherlands, pp: 225-231.

Yildiz, H., M. Palaz and S.A. Doyuk, 2005. Biochemical compositions of mussels (*Mytilus galloprovincialis* L. 1819) in the Dardanelles. J. Food Technol., 3: 430-434.